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# Innovation, competitiveness and salaries: a model of combined growth at the firm level

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## 1. Introduction

The present document is part of a long term research project, which is now in its second year of execution. The main objective is to identify and analyze different competitive strategies at the firm level. This project looks for an explanation of the innovative phenomenon in the particular case of developing countries.

The underlying idea is that specialization trends are crucial for development. This implies that the production of goods with a higher rhythm of technological change (innovation) offers higher perspectives of demand growth and profitability rates, as well as higher salaries (Reinert, 1996; Fagerberg y Verspagen, 2002; Lall, 2004; Ocampo, 2005).

The intensification of knowledge content demands a competitive strategy based on innovation. This strategy is convenient not only for the individual firm but also for the society as a whole, since the logical innovation outcome is the creation of genuine, sustainable and cumulative competitive advantages (Fajnzylber, 1989), which causes both: the firm to stand out from competition and the workers to receive higher salaries.

Several analyses have shown that innovative firms (firms which perform innovation activities –IA-) manage to reach a more successful performance in the long term with simultaneous improvements in productivity and labour quality. This paper presents, in that sense, empirical evidence for the Argentinean case.

The statement that innovation is a media to achieve individual (firm) and collective advantages is a widely theoretically accepted fact: i.e., innovation is a good formula to match growth and development[4]. Nevertheless, when analysing the empirical evidence

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[4] See Lundvall (1992; Kosacoff, 1998; Tether y Swann, 2003; Chudnovsky, López y Pupato, 2004; De Negri, 2005; Borello, Erbes y Yoguel, 2006; Lugones y Suárez, 2006; Lugones, Suarez y Gregorini, 2007; Suarez, 2007).

available about Argentina one can find there are firms that are able to sustain (and in some periods, even enlarge) their participation in the market with a strategy which is not necessarily based on innovation. In fact, in the Argentinean case, there is a significant number of companies who managed to survive one of the worst economic crises in the country (1998 – 2001) and could make the most of the subsequent growth period (2002 – 2004) with a low – or even null – innovation expenditure. At the same time, within innovative firms themselves, there is differential impact regarding economic performance and spillovers towards the rest of the society.

This would be proving that there are different kinds of competitive strategies, with different ways or levels of commitment about innovation. In other words, given the heterogeneity of behaviours in innovative terms, the difference between innovative and non-innovative firms is not enough when you are trying to understand the impact of technological improvement has on development.

The main hypothesis of this paper then, is the assertion that even among innovative firms there are different behaviours with different impact; in terms of productivity and in the spillovers to society as well, which basically translates into genuine competitive improvements. Such differences in behaviour are reflected not only in the degree of commitment with innovation (innovative intensity) but also in the characteristics and continuity of the activities carried out.

If this assertion were true in fact, firms with a low intensity in innovation expenditure – although innovative ones – would be developing a strategy which would not search for significant technological improvements. This kind of short term strategies might be useful in entrepreneurial terms, but they affect the possibility of a long term sustainable development, as there is a low impact on the distribution of the higher incomes and there is an erosion of the profitability margins, if the competition is based on pricing.

Consequently, the aim of the present document is to empirically test the relationship between innovation and income distribution. This paper is aimed at acknowledging the impact of different innovation behaviours, not only analysing the effect on firms but also – and especially – analysing the combined impact in terms of productivity gains and labour quality improvements.

At the same time, we also intend to contribute with the understanding of the relation between innovation and development, based on the identification of strategies capable of driving sustainable development in private terms but also virtuous development in social ones. If we confirmed our hypothesis, then industrial and innovation policies could foster industrial growth as well as an improvement in the income distribution.

## 2. The data set and the methodology

The sample is made up of a total of 1,167 firms which were part of various official statistical surveys during the 1998-2004 period. These surveys are a powerful tool to understand the magnitude and the impact that innovation has on the domestic productive network, even when considering the difficulties which occurred when harmonizing the different surveys, plus a certain bias on the information towards the most successful firms. It is important to bear in mind that during the period under which

the survey was carried out, the domestic economy was facing one of the worst crises in its history, making the firms with the worst performance show high rates of mortality.

The information was collected by the Instituto Nacional de Estadísticas y Censos (INDEC) – *National Institute of Statistics and Census*. These surveys were carried out between 1999 and 2005, and the corresponding data harmonization on the innovation surveys - together with the other data about industry and commerce -is the result of a joint effort of the INDEC and the National Ministry of Economy, so as to match the different statistic data bases. This has led to the Base de Datos de Desempeño Empresarial (BDDE) - *Company Performance Database* – which contains information about the manufacturing industry for the period 1998-2004.

As there was a need to establish control variables which could grasp sectorial specificities without losing representativeness in the sample, the sector differentiation was done according to the technological intensity of goods, according to the OECD classification (Hatzichronoglou, 1996) which divides technology as follows: high, medium-high, medium-low and low technology[5].

Finally, due to the sea change in the relative prices as of the devaluation in 2002, the variables have been deflated by the evolution of producer prices, carried out by the INDEC.

The methodology uses this information and combines some descriptive statistics with an econometric analysis. The first ones will enable the identification of the relevant variables which should be included in the econometric model and the quantification of the phenomenon: productivity, salaries, exports, sectorial specificities, etc.

On the other hand, the econometric model will enable the understanding of the causal relation among the previously identified key variables and the quantification of the impact. The main objective is to develop a model capable of explaining the relation between innovative intensity – as a proxy of innovation commitment - and the level of salaries – as a proxy of the magnitude of the spillovers on labour. We will try to demonstrate that it is possible to implement a competitive strategy based on the search of sustainable and cumulative advantages as well as high salaries. And these strategies are possible no matter the kind of the activity involved. At the same time, we will try to prove that there are strategies which – however innovative – show meagre results in terms of productivity and/or salaries.

## 3. General Findings

As shown in Chart 1, half of the firms belong to the group of activities with low technological content (Low-Tech), which coincides with the total observed for the Argentine productive network. (Lugones and Suárez, 2006). Second, there are firms with Medium-High and Medium-Low technological content, which account for about a fifth of the total universe, respectively. Finally, the lack of industrial firms dedicated to the High technological content (5,7% of the total) evidences the kind of productive

[5] Although this kind of classification does not allow the catching of the technological intensity of the activities developed within each sector, it does constitute itself in a cut variable, capable of differentiating the relative content of knowledge that exists in each of the productive branches.

specialization that has been consolidating during the last few decades in Argentina (Porta, 2007)

**Chart 1: Grouping of firms and innovative participation**

| | Firms | | Innovative ones | |
|---|---|---|---|---|
| | Nº of firms | % | Nº of firms | % |
| **High** | 67 | 5,7 | 55 | 82,1 |
| **Medium-High** | 279 | 23,9 | 230 | 82,4 |
| **Medium-Low** | 236 | 20,2 | 178 | 75,4 |
| **Low** | 585 | 50,1 | 407 | 69,6 |
| **Total** | **1167** | **100** | **870** | **74,6** |

Source: Own drafting over BDDE database (INDEC)

The distribution of the four groups, in those firms which have made some kind of expenditure in innovation activities, is relatively homogeneous, with a significant growth of those with a higher technological content. This is, maybe, the clearest manifestation of the bias towards those firms with a better performance, which are usually positively related to innovation activities. In fact, according to demographic estimations, the percentage of innovative firms in the domestic productive network went up in 2004, to 60% (INDEC, 2006)[6] vs. 74% obtained by the ones in the panel.

*3.1. Innovation, productivity and employment*

The impact of innovation on the domestic economy has been analysed by numerous studies[7]. A considerable amount of economic literature has agreed on highlighting the positive effect that technological innovation has on the main performance indicators. Thus, those firms which dedicate some efforts to innovation show a better performance in terms of sales, exports, productivity and employment. These conclusions have to be especially pointed out in the case of sales, as a better performance does not only refer to a steeper positive trend but also to a more stable one. Chart 2 then shows that those firms which made some innovative efforts, have overcome the crisis more quickly (1998-2001) and have behaved more stably throughout the period too. This conclusion is of utter importance for the research of the national economy, as the economic instability and oscillation have been pointed out as one of the most difficult problems in Argentinean micro-economy in the last few years, influencing the generalized adoption of defensive strategies (wait and see strategies) and flexibility preference (Kosacoff y Ramos, 2006).

[6] We should distinguish the innovative firm – which is the one that has carried out innovation activities (efforts) - from the innovator firm, which has obtained results (innovations).

[7] For a further development of the antecedents about the relation between innovation and economic performance see (Lugones, Suárez and Le Clech, 2007)

**Chart 2: Sales volume evolution Index (1998=100)***

| | Non- Innovative | | Innovative | |
|---|---|---|---|---|
| | Index | Var. | Index | Var. |
| **1998** | 1,00 | - | 1,00 | - |
| **2001** | 0,74 | -26% | 0,90 | -10% |
| **2002** | 0,60 | -20% | 0,95 | 6% |
| **2003** | 0,70 | 17% | 1,08 | 14% |
| **2004** | 0,89 | 29% | 1,25 | 15% |

Constant values 1998.
Source: Own drafting over BDDE database (INDEC)

What is more, the previously shown average values - although valid when comparing firms in terms of their innovative or non-innovative behaviour - do not show the existing heterogeneity within the first group. Thus, it is extremely important to disaggregate the different behaviours about innovation in order to analyse the consequent differential performance.

A first approximation shows us that – consonant with what is happening to the industry as a whole – the innovative firms from the panel make a heterogeneous group in which firms with a different magnitude of innovation expenditure coexist. This is the reason why we have made an analysis of expenditure frequency. As a result, four groups of firms were built, classified according to their innovative intensity -i.e. the relative innovative expenditure activities–, measured by the total expenditure per employee in all the analysed period (1998-2004). Such distribution generates a segmentation in quartiles, which turns into a classification by innovative intensity. Needless to say, this does not show how well or badly strategies were carried out, but their relative positioning in terms of innovative expenditure.

From this segmentation, four groups of firms have been built: in the first quartile we have firms with **Null Intensity (NI)**, which gathers those firms with no innovation expenditure – that is to say, non-innovative ones. In the second group, we have those firms with **Low Intensity (LI)**, which gathers firms who have allocated between $300 and $700 per employee per year. Within the third group we find the ones with **Medium Intensity (MI)**, gathering those firms with an innovation expenditure of between $700 and $1,400 and finally those with **High Intensity (HI)**, those firms who spent more than $1,400 per employee in innovation activities[8].

When calculating the innovative intensity from accrued values (expenditure according to labour for the period 1998-2004) distortions about the expenditure on capital goods are eliminated. Such expenditure is extremely important to meet the innovative efforts, as shown by the innovation surveys carried out in Argentina. Actually, in the period

[8] Although this segmentation is clearly arbitrary, it lets us establish a characterization which is closer to heterogeneity of behaviours than the traditional innovative / non-innovative taxonomy. At the same time, with the exception of the null intensity firms (that are non-innovative), the differentiation among low, medium and high intensity does not imply optimum levels for each kind of firm (in terms of sector or size). It is expected that future investigations will enable to shed some light over the "desirable" levels of innovation investment.

between 1998 and 2004, this field oscillated between 60% and 70% of the total expenditure (INDEC, 2006), which implies a low attention to many fields which should have complemented such investments to achieve a better exploitation of them (training, engineering, R&D, organizational changes, etc.)

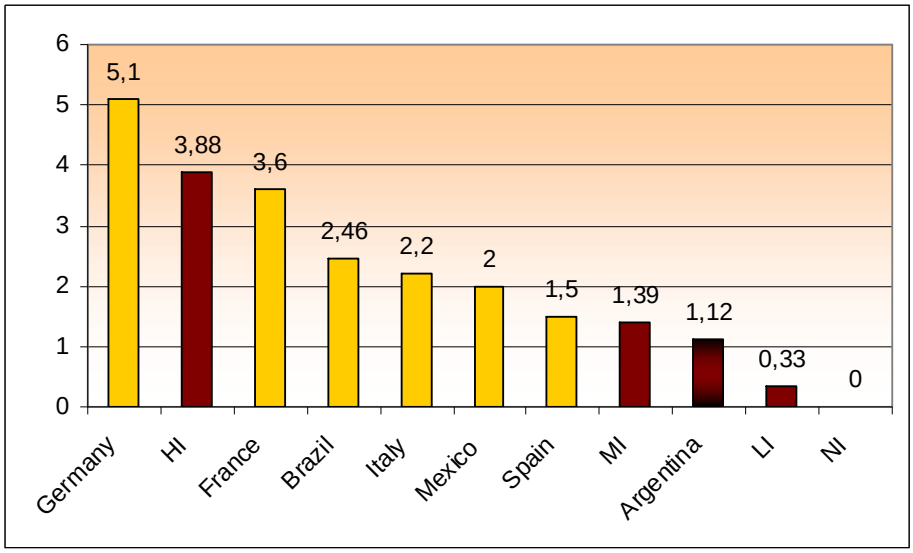
Thus, the expenditure intensity index will only get high levels if the efforts on innovation activities are relatively sustained. This is a better proxy as regards the commitment of the firm towards the search for organizational and technological improvements.

As expected, the higher the innovative intensity per employee, the higher level of expenditure related to sales – though dispersion is also higher as the enterprise becomes larger. The expenditure related to sales enables a better understanding of the level of commitment the firm has with the search for new products and procedures, because it is internationally comparable.

The firms with null intensity included in Graph 1, are – of course – those who have not carried out any innovation efforts. The fact that they have survived the macroeconomic turbulences and the pressure for opening throughout the past decade could be telling of a strategy not based on innovation but adapted to a spurious-like growth, associated with the new relative prices given by a strong and real devaluation of the Argentinean peso at the beginning of the 2000s.

As regards the innovative firms, we can say that the high intensity ones are by far above the Argentinean average, as they rank very closely to German ones. However, if we consider that even the group with the highest innovative intensity proves to have lower proportions than the average reached by the developing countries (values around 4% of the turnover) it is evident that the Argentinean innovative firms have a low level of effort and commitment.

**Graph 1: Innovation Expenditure**
**Selected Countries and Innovation Behaviour**




Innovation expenditure to total turnover. Germany, France, Italy and Spain, year 2004; Brazil year 2003; Mexico, year 2001; Argentina, year 2004. High, Medium and Low innovation intensity: accumulated values (1998-2004).
Sources: EUROSTAT (2006); IBGE (2003), INDEC (2006), CONACyT (2003).

The remaining firms rank among the furthest values: the ones with medium intensity are still above the national average whereas the ones with low intensity show a sharply lower level. The overall low level of expenditure leads, once more, to question the meaning of the index of innovative firms in Argentina (very high compared to the regional and international parameters). The fact that there is scarce allocation of resources for technological and organizational improvements demonstrates that there is a low degree of up-to-dateness in innovation and a consequent low impact in the firm's competitiveness (Lugones and Suárez, 2006).

Another clear characteristic arising from the sample is their distribution in terms of technological intensity and innovative intensity. Obviously, as the classification was made according to the ranking of expenditure on innovation activities per employee; and, as the panel was divided into four, the distribution of intensity shows similar compositions for each group (25%). (Chart 3) But this distribution does not represent what really happens in the industry. A clear example of this is that less than 17.2% of the firms show a level higher than 2.46% in innovation expenditure related to sales – average met by the Brazilian firms. Should you take the European average as a reference (4%), the percentage of companies with higher values is reduced to 10%.

Despite these disappointing results, we should point out that there are firms of diverse intensity in all the sectors. So, even when the "pre-established level of technological intensity" associated with the sector of activity and the expected higher innovative intensity among those activities with a higher content of knowledge, a competitive

strategy based on technological and organizational improvements seems to turn into a viable competitive strategy, even in the so-called "traditional" or "low-tech" sectors.

Therefore, the possibility of a competitive strategy based on innovation among the traditional industries – where most of the Argentinean productive structure lies – might advance towards a higher value added in goods, escaping competition via pricing, so characteristic in these sectors.

**Chart 3: Sectorial distribution according to Innovative Intensity**

| | High | | Medium-High | | Medium-Low | | Low | | Total Panel |
|---|---|---|---|---|---|---|---|---|---|
| | Nº of firms | % | Nº of firms | % | Nº of firms | % | Nº of firms | % | |
| **NI** | 12 | 17,91% | 49 | 17,56% | 58 | 24,58% | 178 | 30,43% | 25,45% |
| **LI** | 10 | 14,93% | 71 | 25,45% | 57 | 24,15% | 170 | 29,06% | 26,39% |
| **MI** | 15 | 22,39% | 77 | 27,60% | 52 | 22,03% | 127 | 21,71% | 23,22% |
| **HI** | 30 | 44,78% | 82 | 29,39% | 69 | 29,24% | 110 | 18,80% | 24,94% |
| **Total** | ***67*** | ***100%*** | ***279*** | ***100%*** | ***236*** | ***100%*** | ***585*** | ***100%*** | ***100,00%*** |

Source: Own drafting over BDDE database (INDEC)

Moving on with the analysis of the impact of innovative activities, the distribution of firms according to their expenditure intensity throws heterogeneous results. Among the most important results of the research project, we observe that the higher the innovative intensity of the firm, the higher the possibility of seeing improvements in the productivity growth[9]. Chart 4 reflects this positive relation between the effort intensity and the productivity growth rate for the 1998-2004 period. While the non-innovative firms (null intensity) show a drop in productivity equivalent to an annual average 0.67%, the high intensity firms account for a level of productivity growth of 4.01%.

In between both ends, there are firms with low and medium intensity, with a growth rate of 0.02% and 2.01%, respectively. Hence, those high intensity firms have a growth rate which is higher by 4.68 points than the ones with null intensity, 4 points if compared to low intensity firms and 2 if compared to the medium intensity ones.

**Chart 4: Productivity and Innovative Intensity**

| | NI | LI | MI | HI |
|---|---|---|---|---|
| **Annual productivity growth rate (%)** | -0,67 | 0,02 | 2,01 | 4,01 |

Productivity: Average annual productivity growth rate period: 1998-2004, constant values 1998.
Source: Own drafting over BDDE database (INDEC)

[9] Despite the lack of relation between sales and employment as an index of productivity, this relation lets us see the difference in size among the firms, beyond their total turnover. At the same time, it is a commonly used index as a performance measurement (Mohnen and Hoareau, 2002; Kemp, De Jongm, Folkeringa and Wubben, 2003; Chudnovsky *et al.*, 2004), therefore, the results will be enriched by the possibility of being compared and discussed with other theoretical and empirical support.

This data would be reflecting that when firms base their competitiveness on the search for technological improvements, they have a clear impact on performance, which does not only reduce costs - which translates into a better pricing competitiveness - but also enables a better positioning in higher value niches or segments, with the consequent improvements in the levels of sales and profitability.

When firms go towards processes and products with a higher content of knowledge, i.e. when they invest a higher proportion of their sales in innovation, their demand for a skilled workforce turns more sophisticated, and this causes an impact on the salary levels. The empirical contrast of this hypothesis is seen when contrasting the innovative intensity to the average level of salaries. Chart 5 confirms this correlation. Those firms with null intensity pay an average salary of $1,090, whereas those with a higher innovative intensity pay salaries of over $1,950; this means 79% higher salaries. Among the intermediate values – and also in direct proportion with the innovative intensity – we can find firms with low and medium intensity which have an average salary level of $1,250 and $1,420 respectively.

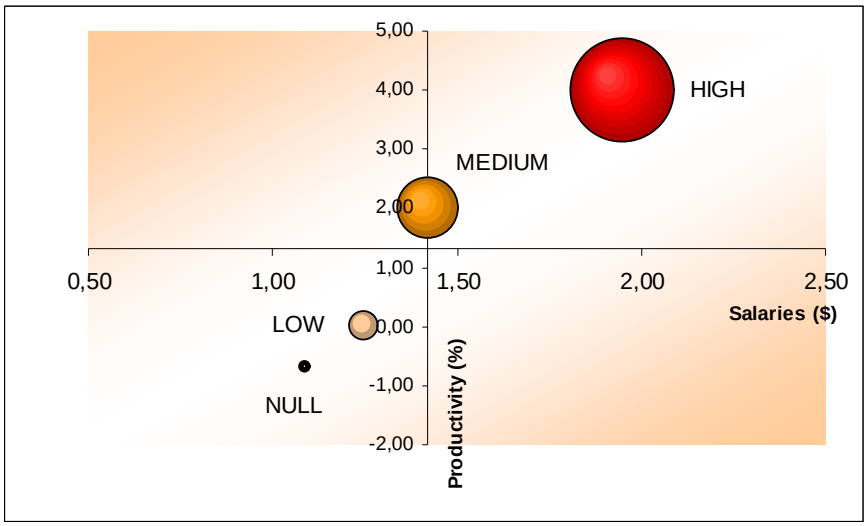
**Chart 5: Salaries and Innovative Intensity**

| | NI | LI | MI | HI |
|---|---|---|---|---|
| **Average Salary (in thousand $)** | 1,09 | 1,25 | 1,42 | 1,95 |

Average salary in 2004.
Source: Own drafting over BDDE database (INDEC)

As a result, the overall analysis of these three variables proves that those firms with a higher innovation commitment make more productivity profits and, at the same time, they offer a significantly higher salary level. As seen in Graph 2, there is a huge distance between innovative firms and non-innovative ones. Bearing in mind that axes intersect in an average value seen for the whole panel (an annual growth rate of 1.31% and an average salary per employee of $1,420) it is clear that non-innovative firms have a negative impact on the total values. Among the different groups of innovative firms, distances are smaller. But there is a bigger difference in both variables between the two levels of lower expenditure and the level of higher intensity.

**Graph 2: Productivity growth and salaries according to innovative intensity**




Productivity: Average annual productivity growth rate in the period: 1998-2004 (Y axis), constant values 1998. Innovative Intensity: quotient between expenditure in IA and sales accumulated 1998-2004 (circles size). Average Salary for 2004 (X axis).
Source: Own drafting over BDDE database (INDEC)

Although most of the innovation expenditure has positive consequences in terms of firm performance, microeconomic advantages and social welfare, the group of firms committed to innovative strategies is extremely small. Therefore, despite being a panel analysis - not comparable to the whole industry - due to the abovementioned bias towards the firms with the best performance – 25.4% of the panel has not carried out innovation activities in the 7 years included in the period 1998-2004 – such percentage would extend approximately to two thirds of the sampling, if firms spending less than 1% of their sales were to be included.

Within the group of firms with lower innovative intensity there is a clear competitive strategy which is not based on the search for significant technological improvements or those with access to high value added niches. Short term strategies like these can satisfy private expectations but they generate scarce spillovers to the rest of the productive and social network, affecting the possibility of a long term sustainable development, because of the poor distribution of wealth or – within the company – because of the erosion of the profitability margins expected in a pricing competitiveness and the foreseeable loss -in the medium term- of the eventual advantages for the real exchange rate.

Among the firms with higher intensity, data dispersion also shows the need to make classification criteria more complex if we want to describe innovative strategies. In other words, we see different results by having the same level of expenditure. This means that although the intensity seems to be a relevant attribute (in fact, previous differences would seem to confirm so), clearly it is not the only one.

How to build ideal innovation strategies escapes from the objectives of the present document. However, we do want to understand the relevant dimensions associated with

expenditure. This implies that it is possible to identify different causes and consequences from their intensity, structure and systematisation of innovative efforts, *ceteris paribus,* aspects like endogenous competencies, technological trends, innovation system and institutional determining factors.

*3.2. Innovative behaviours*

In order to continue with the contrast of the second part of this hypothesis - that the different innovative behaviours are verified not only in their intensity but also in the continuity and characteristics of expenditure – we then classified the firms according to the composition of innovation expenditure (R&D, capital goods, engineering, training, etc.) Therefore, we used the index of innovative strategy balance defined by Lugones, Suárez & Le Clech (2007) which has been summarized in chart 6.

**Chart 6: Description of index of innovative strategy balance**

| Category (i) | Description | Weighting (α) |
|---|---|---|
| a | Research and Development (internal and external) | 0.25 |
| b | Engineering and industrial design (EID) + training | 0.25 |
| c | Capital goods + Hardware | 0.25 |
| d | Technology Transference (TT) + Consulting + Software | 0.25 |

The general notation of the index would be: $BI_j = \dfrac{n - \sum_{i=1}^{n} \dfrac{\left| \left( g_i / IA \right) - \alpha_i \right|}{\left( g_i / IA \right) + \alpha_i}}{n}$ with $0 < BI_j \leq 1$

Based on this index, companies were divided between balanced and biased, differentiating them according to whether they reached a value lower than or the same as or higher than 0.5, in the BI. The first group, the ones we will call **biased**, are characterized by strongly concentrating their innovative efforts in the acquisition of capital goods, or on the contrary, for presenting a low level of efforts in the acquisition of external technology. The second group of firms have a more balanced behaviour because they combine the acquisition of technology and incorporate it with the internal development of knowledge. The abovementioned study shows that this last group, the so called "**balanced**" firms, is the one with the best performance in terms of productivity and sales.

It is important to point out that this index does not intend to define the optimum composition of the innovative efforts – which have strong sectorial specificities – nor does it imply that a "perfectly balanced" strategy (when the index tends to 1) is the optimum strategy. The function of this index lies in the possibility of analyzing different behaviours from the composition of efforts.

Chart 7 shows the salary level and productivity growth rate for the medium and high intensity firms (48% of the panel) discriminating between balanced and biased firms. As seen in the chart, those companies with a balanced behaviour show better levels in both variables. In fact, the average salary in the balanced companies is 18% higher than the one in the biased firms. And while the first group shows an average annual productivity growth rate of 3.01%, the amount increases to 3.14% in the balanced ones.

**Chart 7: Average salary and productivity growth**

| | Balanced | Biased |
|---|---|---|
| **Distribution of the subsample sample * (%)** | 33% | 67% |
| **Productivity annual growth rate (%)** | 3,14 | 3,01 |
| **Average Salary ($)** | 1,89 | 1,60 |

* Medium and High innovative intensity firms.
Productivity: Average annual productivity growth rate in the period: 1998-2004, constant values 1998. Average Salary for 2004.
Source: Own drafting over BDDE database (INDEC)

This lower difference in the productivity growth rate might be explained by the fact that biased firms have a strong expenditure on capital goods (70% of the total expenditure in innovation activities vs. 38% in balanced firms). Without the shadow of the doubt, this has an impact on the production level per employee. In contrast, the difference with the balanced ones in terms of salaries would be showing the aforesaid: if behaviours associated with the incorporation of endogenous technology do not come along with efforts about selection, adaptation and usage (activities like R&D, training and engineering and industrial design) they generate significant improvements in individual terms but they have less social spillovers.

Regarding the continuity of efforts, once again, we analyzed medium and high intensity firms. But this time, we discriminated between firms which had continuously destined efforts in innovation activities during the 7 years of the analyzed period and those who had not. This information is shown in Chart 8. In this case, the differences between one group and the other were bigger: the continuous firms account for an average salary of 23% higher than the one registered by the non-continuous ones, which have a percentage of 35% for the case of productivity growth rate of labour.

**Chart 8: Productivity growth and average salaries**

| | Continuous | Non continuous |
|---|---|---|
| **Subsample* distribution (%)** | 40% | 60% |
| **Annual rate of productivity growth (%)** | 3,61 | 2,67 |
| **Average Salary ($)** | 1,91 | 1,55 |

* Medium and High innovative intensity firms.
Productivity: Average annual productivity growth rate in the period: 1998-2004, constant values 1998. Average Salary for 2004.
Source: Own drafting over BDDE database (INDEC)

As far as the continuity of expenditure is concerned, the key argument is the systematization of the innovative efforts, which is undoubtedly associated with the composition of expenditure. When firms concentrate their activities in the acquisition of capital goods, to think of an uninterrupted expenditure does not seem very reasonable, it might even be anti-economic. On the other hand, expenditure on research and development or engineering and industrial design demand sustainable efforts as they are activities with long term results, and adding to that, there are sunk costs. In other words,

there is evidence to confirm that the possibility of maintaining a sustainable strategy in time (continuous) is bigger among the balanced firms than in the biased ones (Lugones *et al*., 2007; Peirano, 2007).

Continuity also assumes innovation projects of a longer term, which at first sight is associated with a higher scope of the results once they are finally met. To put it bluntly, improving the internal way of doing things might mean new and incremental innovations only new to the firm. On the other hand, getting closer to a better international practice implies, by definition, closing the technological gap which characterizes developing countries.

Chart 9 shows the analysed information in the abovementioned paragraphs but now combining the expenditure composition classification with the continuity classification. Many considerations arise from this combination. Firstly, the importance of the impact between balance and continuity, as this combination reaches the higher levels of productivity and salary growth. Secondly, the scarce impact of productivity and salaries on the balanced non-continuous firms, which might be explained by the kind of activities carried out. These combine endogenous and exogenous efforts, but as they are not sustained in time, they do not have an impact neither on firm performance nor on salaries.

Among the biased firms, the difference between a continuous and discontinuous strategy is smaller, although salary values do differ. A possible explanation could be found in the size and origin of the capital of the firm. While in the continuous biased firms, the big companies account for 10% and medium sized companies for 20%, among the non-continuous, these percentages drop to 3% and 9%. Besides, the foreign capital firms account for 35% of the continuous biased group vs. 19% among the non-continuous. As small national capital companies tend to be less productive, there is a higher chance of obtaining higher growth rates. But this does not happen with salaries; in this case it is clear that larger companies and foreign capital companies have a clear influence on salaries.

**Chart 9: Productivity growth and average salaries**

| **Annual rate of productivity growth (%)** | | |
|---|---|---|
| | **Continuous** | **Non continuous** |
| **Balanced** | 4,3 | 1,9 |
| **Biased** | 3,1 | 3,0 |
| **Average Salary ($)** | | |
| | **Continuous** | **Non continuous** |
| **Balanced** | 2,1 | 1,7 |
| **Biased** | 1,8 | 1,5 |

Productivity: Average annual productivity growth rate in the period: 1998-2004, constant values 1998. Average Salary for 2004.
Source: Own drafting over BDDE database (INDEC)

To sum up, we observe that the level of innovation expenditure is relevant when you have to explain differences in company trends, but it is not enough when you want to fully understand the company strategies which generate simultaneous improvements in productivity and labour. In fact, evidence suggests that there are firms with the same

relative innovative expenditure which show differentiated behaviours. These differences are seen, at least, in the evolution of the firms' productivity and the level of their salaries.

Those firms with a sustained balanced strategy reach higher levels of productivity, which combines with a better labour situation. As you can see, there is evidence to confirm that balanced firms combine not only a higher level of productivity but also a higher level of human capital staffing, meaning the participation of professionals in the total labour. Unfortunately, we also observe that there is an extremely reduced group of firms with virtuous strategies: the balanced with continuous efforts account for 8% of the panel, a percentage which is reduced to 5% if we only consider those high intensity firms. However, this 8% of the continuous balanced firms with high intensity account for 17% of the sales of the panel in the year 2004, and 12% of the total labour.

## 4. The Econometric Model

### *4.1. General Findings*

With the aim of corroborating the relation between innovation intensity and salaries, an econometric exercise has been done in order to approach the relationship causality and magnitude. The main hypothesis of the proposed model points out that the level of the salaries that are paid by each firm (our dependent variable) increases as the intensity of innovation expenditure grows – accumulated expenditure in innovation activities regarding total employment during 1998-2004. This model was applied to the panel of 1,167 cases. Also, sectorial dummy variables were included in order to control each industry specificities, according to the abovementioned classification by technological intensity. At the same time, due to a clear difference in the average salary between national and foreign capital firms, the model has been controlled with a dummy variable related to that particularity. Finally, the effect of labour productivity as well as a variable that represents the specific level of human capital of each company has also been considered.

Taking into account the presented hypothesis, the econometric model is the following:

$$\ln W_i = \alpha + \beta_1 \ln II + \beta_2 \ln P + \beta_3 \ln H + \beta_4 OK + \beta_5 HG + \beta_6 MH + \beta_7 ML + \mu_i \quad (1)$$

where:

$W_i$= Average salary, where the approximate measure is the quotient between the average salary level of the firm and the average salary for the whole panel, according to the values of 2004.

*II*= Innovation intensity, measured as the relationship between the total expenditure in innovation activities and the total employment –for 1998-2004– plus 1[10].

[10] In order to avoid losing observations due to the existence of values equal to zero (data that is null because of the application of the logarithm), a value of 1 is added to variable II as well as H. In any case In(1)=0.

*P*= Labor productivity, as a relationship between sales and employment for 2004, which also allows to control the characteristics related to the size of the firm.

*H*= Human capital endowment, approached through the relationship between the number of professionally trained workers and the total of workers observed for the whole analyzed period, plus 1.

*OK*= Capital origin. This is a dummy variable that takes value 1 to identify the firms that have a foreign capital participation that is higher than 1% over the total capital.

*HG*= High-Tech. This is a dummy variable that takes value 1 to identify the firms belonging to this sector.

*MH*= Medium-High-Tech. This is a dummy variable that takes value 1 to identify the firms belonging to the Medium-High Technology group.

*ML*= Medium-Low Technology. This is a dummy variable that takes value 1 to identify the firms belonging to the Medium-Low Technology group.

$\mu_i$= Identifies the error term of the regression that is assumed to be normally distributed.

This exercise confirms the global significance of each of the variables and the model with an r2 of 0.58. It is also observed that it is not possible to reject the hypothesis of normality in the residual distribution based on the Jarque-Bera test, with a significance level that is higher than 95% and heteroskedasticity problems have been controlled using standard errors consistent with White heteroskedasticity.

As it can be observed in Table 10, all variables show the expected sign and they are significant at levels that are higher than 99%. The variable with larger impact is human capital allocation (0.63), which could be confirmed even without econometric analysis insofar as the higher the qualification level is (graduate professionals) it is clear that the salary will be higher, or the other way around, as the employees have lower levels of formal training, their possibilities to have higher salaries decrease. Next, there is the level of labour productivity (0.075), which partially confirms what the traditional economic theory states as regards the relation between salary and labour productivity. Finally, there is the variable that was expected to be analyzed, that is, the intensity of innovation expenditure (0.0079).

Through this model it is possible to see the positive relation between innovation expenditure and the level of average salaries paid by the firms. On the contrary, in those cases in which the competition strategy of the firm does not include high efforts in innovation – and therefore it can be assumed that such strategy is not based on the search for technological improvement – the characteristics of demanded employment lead to a significantly lower level of salaries regarding the industry in general and each activity sector in particular.

It can be observed that the relationship between the firm salary and the panel average salary is improved due to the level of expenditure in innovation activities, even in those sectors with low technological intensity. To be more exact, the basis comparison or omitted variable is the one that corresponds to the Low-Tech classification, because of

which the starting level is formed by firms with a lower level of average salary than the panel average salary (-0.318), and it increases at a rate equivalent to 0.1217 if it belongs to the High-Tech group, 0.069 if it corresponds to the Medium-High-Tech group, or 0.044 if it belongs to the Medium-Low-Tech group[11]. Once the effects of the technological intensity level of each sector are controlled, **for each percentage point of increase in the total expenditure in innovation activities relative to employment, there is an increase in the relationship between the firm average salary and the panel average salary of 0.008%.**

**Table 10: Results of the Econometric Exercise (OLS Method)**

| Model | Coefficients | Std. Error |
|---|---|---|
| Constant | -0.3183* | 0.0541 |
| LnII | 0.0079* | 0.0016 |
| LnP | 0.0752* | 0.0052 |
| LnKH | 0.6318* | 0.0792 |
| OK | 0.1745* | 0.0150 |
| HG | 0.1217* | 0.0270 |
| MH | 0.0696* | 0.0111 |
| ML | 0.0443* | 0.0122 |
| Dependent variable: LnW<br>R-squared= 0.580358. Included observations: 1167<br>Jarque-Bera Test for Normality = 4.7178 / Ho Prob≈ 0.094<br>White Heteroskedasticity-Consistent Standard Errors & Covariance. Significance at * 1%. | | |

Even though at first sight these values seem low – for each 10% increase of innovation expenditure as regards labour, the average salary increases by approximately 0.08% – they are not so if we take into account that the equation is also considering key variables when determining the salary, such as productivity and the allocation of professionals. For every increase in innovation expenditure, the direct impact in salaries, *ceteris paribus* productivity evolution and human capital, the salary increases in a 10 to 0.08 ratio.

Consequently, the increase in innovation expenditure means some kind of positive result that should be also seen in productivity and the need of skilled labour. That is to say, innovation expenditure is also determining the levels of the other two key variables considered in the model, which in turn have a direct and significant impact in the salary: for each increase in productivity and human capital allocation, the salary increases by 0.075% and 0.63%, respectively.

[11] Applying antilog to cancel the effect of Ln in the calculation.

To sum up, innovation intensity has direct impact not only in labour but in productivity as well, and as long as firms move towards goods with more knowledge content, the labour demand becomes more sophisticated, which implies a higher level of human capital. All this has a clear impact in the salary and the competitiveness levels, whether it is due to product differentiation or because of improvements in the productive efficiency. At the same time, the fact that they are companies with different technological content confirms once more the importance of innovation as a source of competitive, sustainable and cumulative advantages, even in sectors with low or medium technological intensity.

*4.2. Innovative Behaviour*

In order to test the relationship between intensity and innovative behaviour, the regression was run again, but this time distinguishing between biased and balanced firms. The results are shown in Tables 12 and 13.

As you can see, in balanced companies High and Medium High sectorial control variables as well as the variable that controls the foreign capital participation are no longer significant, which means that is very likely they tend to zero. The fact that the constant of the equation is also non-significant implies that the omitted variable (Low Tech) is not significant either. To put it bluntly, sectorial or capital property belonging is not relevant any more, as long as there is a high possibility that the coefficients of these regressors are close to zero. On the contrary, the variables of Human Capital, Productivity and Innovation Intensity have a positive and significant impact (at significant levels that are higher than 99%).

**Table 12: Results of the Econometric Exercise (OLS Method)**

**Balanced Companies**

| Model | Coefficients | Std. Error | Sig. |
|---|---|---|---|
| Constant | -0.6706 | 0.1965 | 0.0008 |
| LnII | 0.0635 | 0.0171 | 0.0003 |
| LnP | 0.0752 | 0.0160 | 0.0000 |
| LnKH | 0.5538 | 0.1373 | 0.0001 |
| OK | 0.1690 | 0.0289 | 0.0000 |
| HG | 0.0533 | 0.0551 | 0.3343 |
| MH | 0.0240 | 0.0302 | 0.4280 |
| ML | 0.0138 | 0.0333 | 0.6799 |
| Dependent variable: LnW. R-squared= 0.563689. Included observations: 188.<br>Jarque-Bera Test for Normality = 1.0081 / Ho Prob≈ 0.604<br>White Heteroskedasticity-Consistent Standard Errors & Covariance. | | | |

**Table 13: Results of the Econometric Exercise (OLS Method)**
**Biased Companies**

| Model | Coefficients | Std. Error | Sig. |
|---|---|---|---|
| Constant | -0.4926 | 0.1092 | 0.0000 |
| LnII | 0.0214 | 0.0096 | 0.0263 |
| LnP | 0.0823 | 0.0099 | 0.0000 |
| LnKH | 0.1467 | 0.1306 | 0.1769 |
| OK | 0.1690 | 0.0289 | 0.0000 |
| HG | 0.1932 | 0.0219 | 0.0000 |
| MH | 0.1032 | 0.0205 | 0.0000 |
| ML | 0.0664 | 0.0220 | 0.0027 |
| Dependent variable: LnW. R-squared= 0.538940. Included observations: 374.<br>Jarque-Bera Test for Normality = 2,500 / Ho Prob≈ 0.2858<br>White Heteroskedasticity-Consistent Standard Errors & Covariance. | | | |

Human capital endowment still has the larger impact, but it is smaller than the one observed in the general panel, which could be the result of a higher general level (among the balanced companies there are 1.5 professionals every 10 employees, whereas among the biased companies, this ratio is reduced to 0.9 to 10), which reduces the marginal impact of an increase in skilled labour allocation. As regards the impact of productivity, it is practically identical to the values for the general panel, which in turn is consistent with the values presented in previous sections where there could be noticed similar levels of productivity growth rates between balanced and biased companies.

As regards the impact of innovation expenditure, the differences are remarkable. Among the balanced firms, for each percentage increase of the relationship between innovation expenditure and labour, the direct impact in the salary is almost 8 times the impact shown for the total panel (0.063 against 0.008). In other words, the balanced innovation expenditure, regardless of the technological intensity of the sector, generates spillovers from the improvement of the salary levels, together with higher productivity and labour quality levels.

Regression among biased companies produces somewhat different results. In this case, all variables are still relevant, except for innovation intensity and human capital. This means that variations in innovation expenditure intensity have an impact close to zero in the average salary, being productivity the variable with the highest coefficient. It is also remarkable that human capital allocation has a non-significant coefficient.

Secondly, it is also important to notice that the sectorial impact is higher, which is also probably absorbing the impact of human capital allocation. That is to say, the difference between the firm's salary level and the average salary level will be mostly determined by the firm's technological intensity. As mentioned before, the Argentinean productive structure is characterized by a low level of technological intensity. That is why salaries are determined by the expertise pattern that our country has. Furthermore, among the biased firms (most of the innovative firms), even though the search for technological improvement does not have a negative impact on salaries, it does not generate direct spillovers either.

Finally, the continuity criteria should be tested. The advantage of including this restriction is that it allows to approach better the sustained strategies for searching for technological improvement by means of relatively intense and combined expenditure.

To test this, the sample was segmented in the four categories that result from a cross-section of the balance in innovation expenditure and the continuity of efforts. Therefore, the compared groups will be: balanced continuous (BC), balanced non-continuous (BNC), biased continuous (SC) and biased non-continuous (SNC). (Table 14)

In order to test the presence of differences as regards salary, human capital endowment, productivity, and innovation intensity, the Kruskal-Wallis Test was performed instead of the original regression, which can also disregard the assumption of normality in the analyzed variables distribution. At the same time, in order to unify the variables, they were divided by the general panel average, resulting in the new measures of salary, productivity, human capital endowment, and innovation intensity.

**Table 14: Average Salaries and Productivity (Average Base = 1)***

| | BC | BNC | SC | SNC | Total |
|---|---|---|---|---|---|
| **Salary** | 1,44 | 1,20 | 1,26 | 1,04 | 1,19 |
| **Innovation Intensity** | 2,23 | 1,06 | 3,35 | 1,60 | 2,02 |
| **Productivity** | 1,70 | 1,05 | 1,25 | 1,22 | 1,28 |
| **Human Capital** | 2,02 | 1,94 | 1,47 | 1,03 | 1,45 |

*Companies with medium and high innovation intensity.
Salary: average year 2004, innovation intensity: 1998-2004 accrued expenditure regarding total labour, labor productivity: year 2004, human capital: professionals regarding 1998-2004 average total labour.
Source: Own elaboration based on BDDE database (INDEC).

This test is based on the ordering of the values reached by the analyzed variables, from which an estimation is made of the average value within these observed orderings for each analysis group (in our case, the ranking is between 1 and 562, and the averages are calculated for balanced continuous, balanced non-continuous, biased continuous and biased non-continuous). The Kruskal-Wallis statistical test calculates how the ranking value within the group is different from the average value of all the groups based on a chi-square distribution. The results of the analysis are shown in Tables 15 and 16.

From the contrast statistical test, it is possible to reject the null hypothesis. This means there is some kind of association between the average values and the groups, with a significance level that is higher than 99%. That is to say, the averages are significantly different among groups. However, it can also be observed that the ordering is not identical for all the variables.

As regards average salary and productivity of employment in 2004, continuity seems to have more influence than the expenditure pattern, which can be seen in a higher average range among the continuous as regards the non-continuous (first the balanced and then the biased).

On the contrary, in the variable of human capital, the influence of the expenditure structure (balance) is higher than the variable of continuity, and in the variable of innovation intensity, biased continuous firms stand out, although continuity also seems to be a relevant dimension.

**Table 15: Ranges Based on Behaviour**

| | Salary | Innovation Intensity | Productivity | Human Capital |
|---|---|---|---|---|
| **BC** | 346.92 | 320.86 | 323.3 | 346.31 |
| **BNC** | 283.98 | 224.1 | 267.35 | 328.05 |
| **SC** | 311.34 | 349.25 | 313.93 | 296.67 |
| **SNC** | 238.63 | 251.16 | 252.86 | 230.09 |

Observations included: BC: 96, BNC: 92; SC: 131; SNC: 243. Total observations: 562.

**Table 16: Contrast Statistical Test***

| | Salary | Innovation Intensity | Productivity | Human Capital |
|---|---|---|---|---|
| Chi-square | 36,965 | 48,430 | 19,846 | 48,404 |
| df | 3 | 3 | 3 | 3 |
| Asymp. Sig. | ,000 | ,000 | ,000 | ,000 |

* Kruskal-Wallis Test

These results may be revealing the fact that the continuity of the innovation efforts is a key determining factor of the impact of these efforts whereas in view of the relative values observed in Table 14, a more complex strategy for seeking technological and organizational improvement (internal generation and external acquisition of knowledge) helps to reach even higher levels of productivity, salary and human capital.

In other words, the combination of balance and continuity is the behaviour that shows the most profitable results as regards productivity and employment. The intensity of innovation expenditure that is observed among biased continuous firms deserves a special explanation. This high relative value that is observed in this group is again associated to the level of capital assets expenditure. As a matter of fact, among the biased continuous firms the expenditure in this item equals 70% of the total expenditure, while among the balanced continuous firms this percentage is reduced to 41%. These percentages, which in turn are the ones that determine the classification between biased and balanced, lead to a larger participation of the total expenditure as regards employment and sales. As it was mentioned before, the capital goods expenditure represents the largest part of the Argentinean firms' expenditure. That is why it is not surprising that these firms show higher intensity values.

Finally, in order to test the impact of the different behaviours, that is, if there is an ordering as regards results of one behaviour or another, the Jonckheere-Terpstra test was performed. This test enables to check the null hypothesis that states that the analyzed variables do not show an ordering associated to the membership group. The alternative hypothesis states that the balanced continuous companies (1) reach better levels than the balanced non-continuous ones (2), which, in turn, reach higher values

than the biased continuous firms (3) and the latter reach higher values than the biased non-continuous (4), in each of the analyzed variables (salary, productivity, human capital and innovation intensity). The results are shown in Table 17.

**Table 17: Jonckheere-Terpstra (J-T) Test***

| | Salary | Innovation Intensity | Productivity | Human Capital |
|---|---|---|---|---|
| Observations included | 562 | 562 | 562 | 562 |
| Observed J-T statistical test | 43692,000 | 49966,000 | 48429,000 | 40667,500 |
| Statistical J-T average | 55488,500 | 55488,500 | 55488,500 | 55488,500 |
| Statistical J-T standard deviation | 2105,395 | 2105,395 | 2105,395 | 2104,288 |
| Standardized statistical J-T | -5,603 | -2,623 | -3,353 | -7,043 |
| Asymp. Sig. (bilateral) | 0,000 | 0,009 | 0,001 | 0,000 |

* Number of levels (innovative behaviour): 4. Ordering: BC:1; BNC:2; SC:3 and SNC:4.

Given the value of the standardized statistical and the significance levels, it is possible to reject the null hypothesis. The statistical less than zero in all the variables implies that there is an ordering negatively correlated with the pre-established ordering for the groups. In other words, the balanced continuous firms show higher values in all the analyzed variables than the biased non-continuous firms.

Again, this kind of analysis does not make it possible to draw larger conclusions regarding distances among groups, although it can be expected that the value differences between the extreme groups would be larger in the salary and human capital allocation levels (where the statistical J-T reaches a value of -5.603 and -7.043, respectively) and smaller in the productivity and innovation intensity levels (-3.53 and -2.62). That is to say, the significance and robustness analysis confirm what was observed with the descriptive statistics that was presented at the beginning of this section and in the previous ones.

## 5. Summary and Conclusions

This document represents an effort to understand better the current connections between innovation activities performed by the firms and income distribution in Argentina. In doing so, and on the basis of a panel made up of 1,167 companies that were asked about their innovative behaviour and their company performance, we analyzed the differential impact of different strategies on the individual productive performance as well as their spillovers regarding a higher social welfare.

The heterogeneous Argentinean productive system includes companies with different dynamism and commitment regarding innovation. In spite of the existence of an important group of firms with good performance in markets and little commitment in terms of research and innovation, the results of this document show that the companies

that make the larger efforts on innovation are the ones that get the best results regarding productivity as well as having a progressive impact on income distribution.

In order to approach this subject, the group of firms of the panel was divided in four groups according to the level of their innovation expenditure for 1998-2004. The data analysis shows that those firms that are mostly committed to competitive strategies based on the search for technological improvements hold the largest profits in productivity, combined with significantly higher salary levels. Despite the good results, the firms with competitive strategies, where innovation plays a major role, are an extremely small group compared to the total local productive network.

The positive relation between innovation expenditure and the salaries paid by the companies was tested using an econometric model that helped to confirm that the increase in innovation expenditure mean a positive result on the salaries. The model reflects that the impact of innovation on the salaries is even larger if it is considered that innovation activities also affect productivity and the qualification level of the employees, which are variables that are positively correlated with the salary paid by the firm. On the other hand, by including firms with activities that have different levels of technological content, the study shows that innovation turns out to be a source of competitive, sustainable and cumulative advantages, even in sectors with low or medium technological intensity that dominate the local productive structure.

Apart from the general level of intensity of innovation expenditure, the firms with similar commitment to innovation have different behaviours that are present not only in the evolution of the firm productivity but in the salary levels as well. In order to distinguish the different strategies of the innovative firms, not only the level of commitment to innovation was considered but also the continuity of these activities over time, as well as the balance in their composition. Therefore, it was confirmed that those companies that have a balance in the expenditure of the different items of innovation (balanced) show a better performance in productivity and sales, compared to those that have biased their innovative efforts towards the acquisition of capital goods. It should be noted that the biggest differences between both groups are not only in their productivity evolution but also in the spillovers to society regarding improvement in income levels.

As regards the continuity of innovation expenditure we can observe that those companies that have chosen innovation strategies sustained over the analyzed period also show a better performance than those companies that have done erratic expenditure. This way, the so-called continuous firms pay average salaries that are 23% higher than the ones registered in the non-continuous companies, while the differences among them as regards labour productivity growth rate are 35%.

A series of econometric studies show interesting results about the performance associated to each of the described strategies. That is why the continuity of the innovation efforts is a key determining factor of the impact of these efforts whereas a more complex strategy for seeking technological and organizational improvement (internal generation and external acquisition of knowledge) helps to reach even higher levels of productivity, salary and human capital. The combination of balance and continuity is the behaviour that shows the most profitable results as regards productivity and employment. However, also in this case it should be remarked that firms with

virtuous behaviour are an extremely reduced group, since companies with balanced expenditure and continuous efforts are only 8% of the panel, which also shows a bias towards those companies with better performance.

In short, and as regards the hypothesis presented at the beginning of this document, we could confirm that the intensity of innovation expenditure, the combination of endogenous and exogenous activities and the systematization of the efforts are three determining dimensions in the analysis of the business strategy, as these kinds of behaviours lead to differential impacts in productivity and employment. We can also observe that even though there are proven benefits of these kinds of behaviours, they are not more than a reduced group of firms, which also shows alternative ways to maintain the competitive levels or to manage to survive in the market.

The change in relative prices resulting from the devaluation and the explicit objective to maintain a high exchange rate that benefits exports is clearly a determining factor in the evolution not only of the firms with virtuous behaviour but also of the companies where competitiveness is based on other factors. In any case, the study herein suggests that in order to maximize the possibilities of industrial growth to be an effective means for development, it is necessary to generate active and specific policies to that end, rewarding or helping innovative strategies, which here are called “virtuous”.

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